Space Weather Technical Forecast

Issued on Tuesday, 14 February 2023 at 00:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further isolated M-flares (R1/R2 Radio Blackouts) likely, with a Slight chance of isolated X-flares (R3 Radio Blackout). Chance of G1/Minor Storm on Days 1 and 2 (14-15 Feb). Active fluence expected on Day 1 (14th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate during the period, with a two low-level M-flares.

There are currently 13 sunspot regions on the visible disc. However, most regions are either small and magnetically simple or relatively stable and unremarkable. However, there are two larger regions approaching the northwest limb, AR3213 (Fai/Beta-Gamma) and AR3214 (Eki/Beta). AR3214 has been relatively quiet and stable, with AR3213 continuing to show decay in it's trailing portion as it nears the limb, but producing a C7 flare at 13/1540UTC. The other other most noteworthy region, already mentioned, and perhaps now the most significant, is AR3226 (Dai/Beta-Delta) which has continued to mature after rapid development, and may now contain a small Delta spot. AR3217 in the southeast, which had previously been the source of significant flare activity, has continued to decay and is now classed as Hhx/Alpha.

No Earth-directed CMEs have been observed in available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, started slightly elevated around 410 km/s but steadily declined to ambient levels, around 340 km/s. However, a sharp but modest increase was observed around 13/1930UTC back to 417km/s before reducing slightly. The density was predominantly at average levels but briefly peaked around 12ppcc prior to the increase in solar wind speed mentioned above. Total IMF, Bt, remained weak (5nT or less), but a slight increase was noted after 13/1800UTC. The north-south component was weak +/- 3 nT. The Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at background levels. The high energy electron flux (greater than 2MeV) measured by GOES-16 was at Moderate to High levels, with a peak of 5450pfu at 13/1725UTC. The associated 24-hour electron fluence rose above the Active threshold. The fluence at 14/0001 UTC was 1.35e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain Moderate, with further isolated M-class flares. There is a slight chance of becoming High with any isolated X-flare.

Solar Wind / Geomagnetic Activity: 10th and 11th CMEs may give further glancing impacts at Earth on Days 1 and 2 (14-15 Feb), although these are most likely to be weak. There are no significant coronal holes in the forecast at present.

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Geomagnetic activity is therefore expected to be mainly Quiet, occasionally Unsettled, with a low chance of rising to Active to G1/Minor Storm on Days 1 and 2 (14th and 15th) should any CME effects become more significant.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of exceeding S1 in response to any significant flares. High energy (greater than 2 MeV) electron flux is expected to be Moderate to High on Day 1 (14th), but on an overall declining trend through the period. The associated 24 hour fluence is expected to start the period above the Active threshold (1e8 integrated pfu), before likely decreasing below Active from Day 2 (15th).

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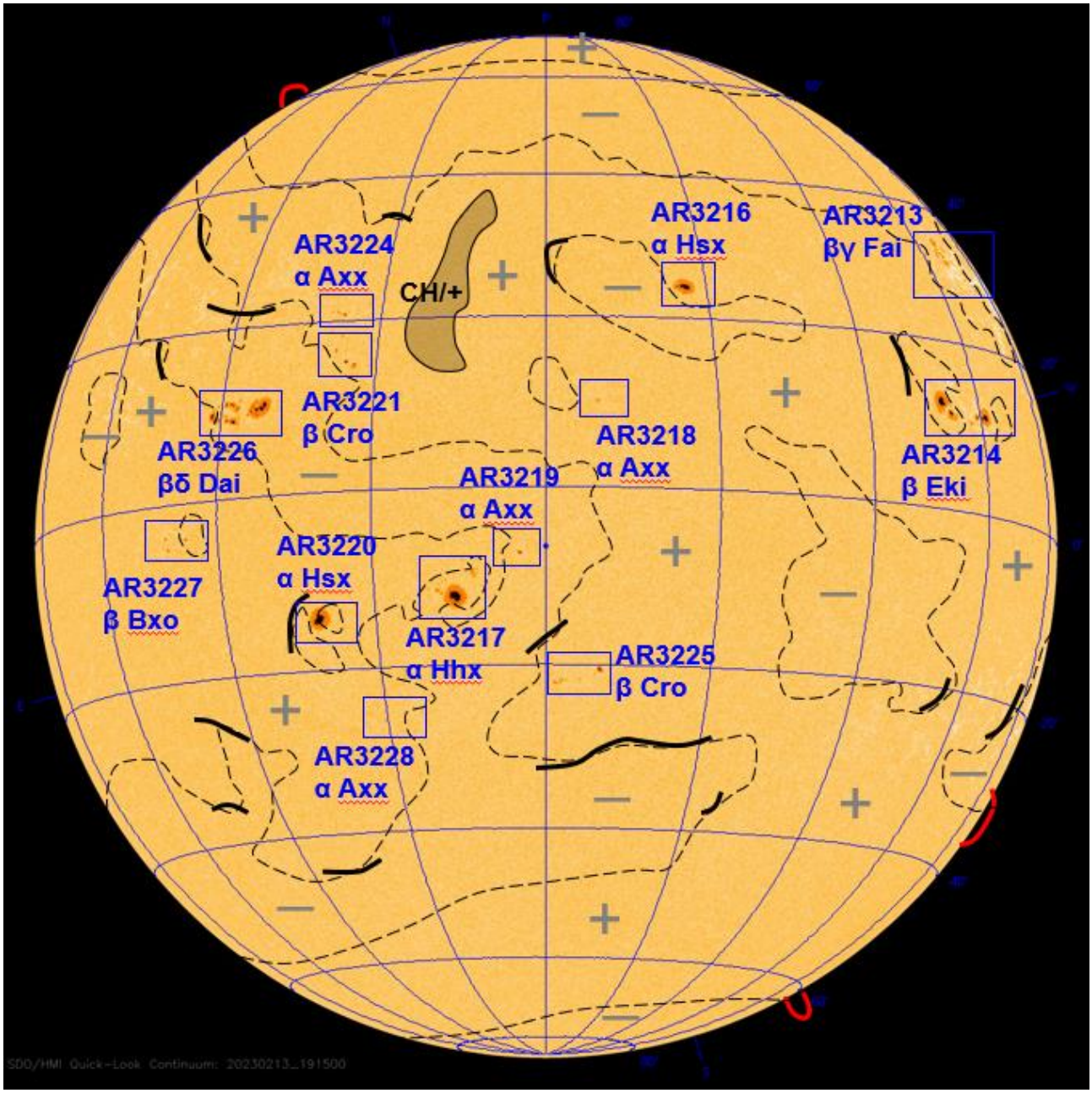
Figure 1. Solar Analysis Valid 13/1930UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The anticipated 11th Feb CME appears to have reached the DSCOVR satellite around 13/1930UTC, with weak effects on solar wind parameters thus far. Further mainly weak effects are likely to persist into early Day 1 (14 Feb). There is also the chance of the CME from 10th Feb giving a glancing pass from late on Day 1. However, effects from this CME are also anticipated to be mainly weak.

Otherwise, there are no significant coronal holes in the forecast at present, so the forecast for the coming few days mainly concerns any further glancing CME effects. Assuming these remain mostly weak, the solar wind speed is likely to remain at largely ambient levels. Enlil is suggesting a High Speed Stream arrival on Day 3 (16 Feb), but current imagery indicates this is unlikely. Geomagnetic activity is therefore expected to be mainly Quiet, occasionally Unsettled, with a low chance of rising to Active to G1/Minor Storm on Days 1 and 2 (14th and 15th) should any CME effects become more significant.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	10	1	1
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/2148 UTC	Partial	Filament	SW	420	14/1800UTC	Low chance of glancing blow

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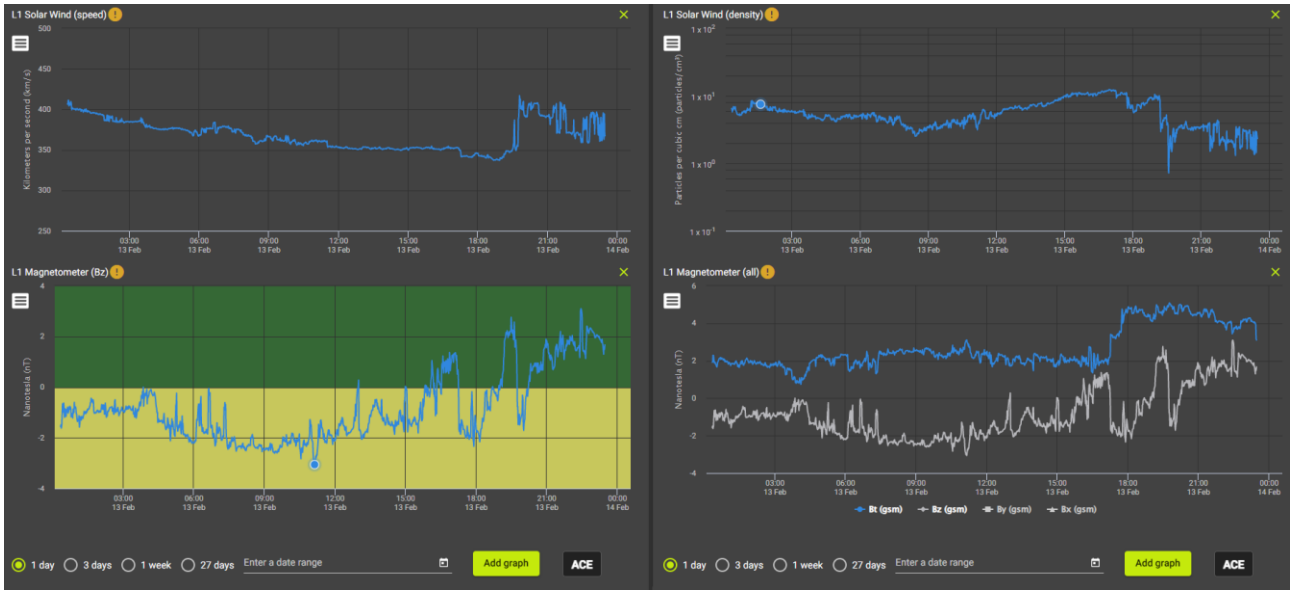
Figure 2: Solar wind parameters from the DSCOVR satellite showing likely weak CME influence on the evening (UTC) of 13th.



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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate in the last 24 hours, with two M1 flares from AR3226 (Dai/Beta-Delta) in the northeast quadrant.

There are currently 13 numbered regions on the Earth-facing disc. Most regions are either small and magnetically simple or relatively stable and unremarkable. However, there are two larger regions approaching the northwest limb, AR3213 (Fai/Beta-Gamma) and AR3214 (Eki/Beta). AR3214 has been relatively quiet and stable, with AR3213 continuing to show decay in it's trailing portion as it nears the limb, but producing a C7 flare at 13/1540UTC. The other other most noteworthy region, already mentioned, and perhaps now the most significant, is AR3226 (Dai/Beta-Delta) which has continued to mature after rapid development, and may now contain a small Delta spot. AR3217 in the southeast, which had previously been the source of significant flare activity, has continued to decay and is now classed as Hhx/Alpha.

Further isolated M-class flares are likely, with a slight chance of isolated X-class flares. A slight reduction in risk is indicated as some larger regions start to rotate off the west limb, and far side seismographs and STEREO-A EUV imagery are suggesting that no significant regions are likely over the next few days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. No notable high energy proton response has been observed from recent M-flares. Any further significant flares may increase count rates, with a slight chance of exceeding the S1 level. AR3213 (Fai/Beta-Gamma) will rotate off the disc late on day 1 (14 Feb) with a gradual decline in proton risk thereafter. There remains some proton risk from AR3217 moving into a more favourable location for Earth-directed events, although this region appears to be on a decay trend.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	15	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GOES-16 was at Moderate to High levels, with a peak of 5450pfu at 13/1725UTC. Solar wind speeds have been mainly at background levels, although there is evidence of weak CME interaction at present. and there is the possibility of a further glancing CME from late on day 1 (14th).

The associated 24 hour fluence has risen just above the Active level, and is now significantly above both REFM and recurrence predictions. There is uncertainty as to how significant these passing CME effects may be on the electron counts. However, considering the period as a whole, an overall decrease is expected, with fluence levels probably falling back below the Active threshold from day 2 (15th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	100	50	20	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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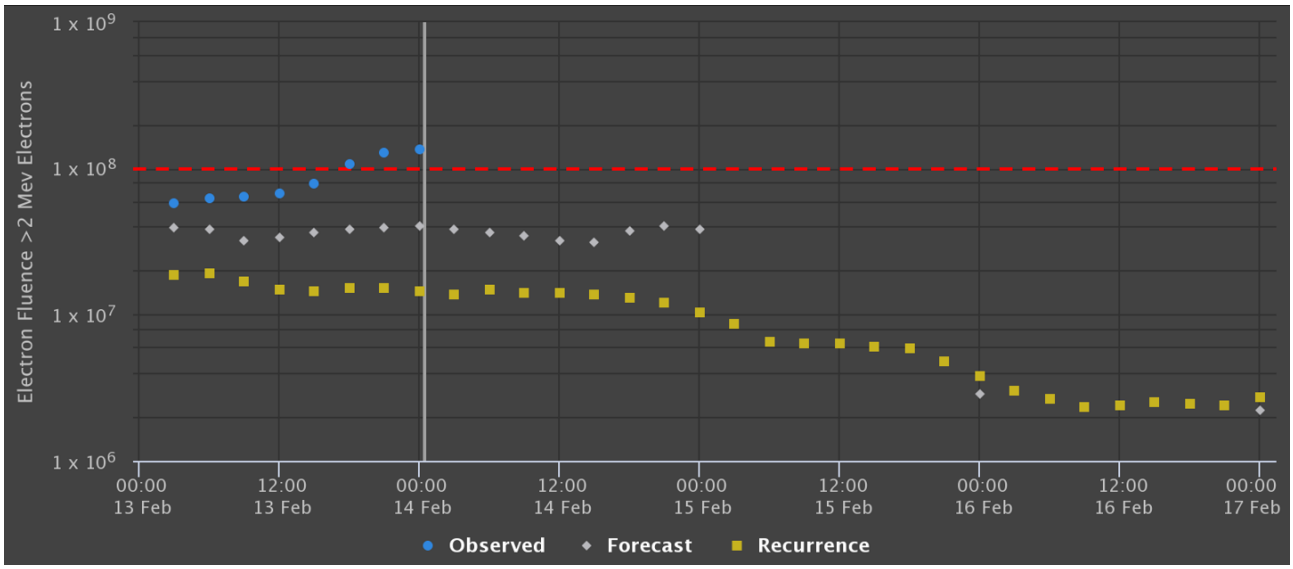
Figure 3: MOSWOC REFM



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